UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
MIDWEST AREA

and

Wisconsin Agricultural Experiment Station and other State Experiment Stations, Cooperating

MISSISSIPPI VALLEY REGIONAL SPRING BARLEY NURSERY - 2003 Crop

Preliminary Quality Report

A. D. Budde, C. Martens, D. M. Peterson, M. Schmitt and Staff

---

This is a joint progress report of cooperative investigations being conducted in the Agricultural Research Service of the U.S. Department of Agriculture and State Agricultural Experiment Stations. It contains preliminary data that have not been sufficiently confirmed to justify general release; interpretations may be modified with additional experimentation. Confirmed results will be published through established channels. The report is primarily a tool available to cooperators and their official staffs and for those persons who have a direct and special interest in the development of improved barleys.

This report includes data furnished by the Agricultural Research Service as well as by the State Agricultural Experiment Stations. The report is not intended for publication and should not be referred to in literature citations nor quoted in publicity or advertising. Use of the data may be granted for certain purposes upon written request to the agency or agencies involved.

Samples malted and analyzed by the Cereal Crops Research Unit, Madison, WI

Dec 2004
CCRU-MWA-122

Mississippi Valley Regional Spring Barley Nursery – 2003 Crop

Nursery samples were received for malting quality evaluation from five experimental stations located in Idaho, Minnesota and North Dakota. The parentages of the nursery entries are listed in Table 1. Fifteen of the thirty entries were new in this year's nursery.

These samples were germinated for 5 days and rotated for 3 minutes every half hour, which should have yielded malts having modification levels similar to those produced by industry. The malting conditions and analytical methods employed are listed in Appendix A. The criteria and value assignments used to calculate quality scores are listed in Appendix B

The mean values for 14 quality factors are listed over the four stations located in the Mississippi Valley Region (Table 2) and over all varieties (Table 3). Tables 9 and 10 include the stations used for tables 2 and 3, in addition to data from the Aberdeen, ID location, which lies outside of the Mississippi Valley. Individual station data are reported in Tables 4 through 8. The parentages of the nursery entries are listed in Table 1. Evaluations of data from individual locations and overall performance evaluations (derived primarily from Tables 2, 3, 9 and 10) are presented below.

The barleys from Crookston, MN were generally plump and had good protein contents. Most extract, F-C and free amino nitrogen values were good. The soluble protein values were generally good, with only two being too low, while five just exceeded the upper limit. Enzyme levels were mostly within the acceptable range, with one diastatic power value that was too low and five that exceeded 200 20°DU ASBC. Most of the β-glucan levels were too high indicating that these barleys were under-modified by our standard malting protocol. The best performers were 6B98-9339, M115, Lacey, BT495, Tradition, M109, and BT490. 6B98-9339 outperformed the experimental controls and has a nice malting quality profile, except for slightly elevated turbidity and β-glucan values. The rest of the best performers had excellent quality profiles also, with the exception of unacceptably high β-glucan levels. Note that Newdale would have scored much higher with improved plumpness, had excellent β-glucan contents and a six-row like enzyme package.

Most of the experimental barleys from Morris, MN were plumper than the control varieties, while their protein contents were generally lower. Most of the extract, F-C, soluble protein and amylolitic values were good. Fourteen S/T values were too low, while three were too high. Both the β-glucan and FAN levels were elevated. Nearly a third of the turbidities were too high, although only one wort clarity was considered slightly hazy. The best performers were ND17643, ND17655, Drummond, 6B98-9339, M109, M115 and 2ND19119. ND17643 had a slightly elevated free amino nitrogen level and was a bit turbid. ND 17655 and Drummond had solid malting quality profiles. Better modification of 6B98-9339 would have decreased its β-glucan value, while increasing the soluble protein level, thus improving both of these parameters and elevating the S/T ratio to an acceptable amount. M109 had a solid quality profile, with only a slightly elevated turbidity. M115 had a total protein content that was a bit high, but acceptable. 2ND19119 was very plump, had excellent β-glucan contents, but slightly elevated S/T and free amino nitrogen values. ND17711, M117, ND18579 and ND18650 scored well also, but the elevated turbidities should be watched. Note however, that the worts of all of these lines were visually rated "clear".

The barleys from Bottineau, ND were very plump, but eight had unacceptably high protein contents. Five extract values were too low, while a third of the F-C differences were too high. The soluble protein levels were generally good, but half of the S/T ratios were too low. The amylolitic values were good, while all but one β-glucan value exceeded the acceptable limit. Nearly half of the turbidities were too high and half of the free amino nitrogen levels were over 250 ppm. The best performer in this experiment was Newdale. This line had an acceptable β-glucan level, and all other malt quality factors were good. This 2-rowed line has a 6-row like amylolitic package. Other lines such as M117, M109, Lacey, and M116 scored better than Newdale, but their elevated turbidities should be noted. The internal Morex Malt Check in this experiment did not modify as well as would have been expected, suggesting there may have been a problem with our malting of these lines.

A third of the barleys from Osnabrock, ND were thin, but the only two protein contents that were unacceptably high were those of Barbless and Morex. Only five extract and six soluble protein values were too low, and F-C differences were generally good. However, the low soluble protein levels combined with the elevated total protein contents resulted in

unacceptably high S/T ratios in over two thirds of the malts. Most of amylolitic values were good, with only four diastatic power levels falling below desired limits. Over a third of the β-glucan levels were unacceptably high, but the β-glucan values of a couple lines indicated possible over-modification. There was sufficient free amino nitrogen development in all lines, except Barbless and 2ND19929. The best performers at Osnabrock were ND17655, 6B98-9170, M115, Legacy, ND17643, 2ND19119, M112 and Lacey. ND17655 had an excellent malting quality profile, with only a slightly elevated turbidity as a note of concern. 6B98-9170 also had an excellent quality profile, with only a low S/T ratio as a concern. M115 had a good malting quality profile except for an elevated turbidity and a diastatic power value that was lower than anticipated. Legacy was one of the experimental controls for this nursery and had a good malt profile, but was a bit under-modified by our standard malting protocol as determined by the slightly elevated β-glucan level. ND17643 showed good malt quality, except for a low S/T ratio. 2ND19119 showed great potential as a 2-rowed entry in this nursery. This line had impressive plumpness and extract values. The line may have been a little over-modified, since its β-glucan level was quite low and the S/T ratio was high. The slightly elevated turbidity of this extract should be noted. M112 and Lacey both had good malt quality profiles, but had low S/T ratios and slightly elevated turbidities.

The barleys from Aberdeen, ID were plump, except for Barbless and had excellent protein contents. Extract values were very good, except for that of Barbless. Protein modification was an issue in lines from this location and resulted in low soluble protein, S/T and diastatic power values for about two thirds of the submissions. The β-glucan levels of nine lines were unacceptably high and turbidities were high in over half of these submissions. The free amino nitrogen levels of these lines were sufficient, except for that in 2ND19098. The best performers were 6B98-9339, 6B99-6639, 6B99-6774, 2ND19119, ND17655, and Drummond. 6B98-9339 had a fairly good malt quality profile, but the diastatic power value was unacceptably low, while the wort color was high, most likely due to the high turbidity. 6B99-6639 had a good malt profile, except for a very low diastatic power value. 6B99-6774 had an elevated β-glucan level and its diastatic power level was low. 2ND19119 had a very good malt quality profile except for a high color value, most likely influenced by the elevated turbidity. ND17655 had a solid malting quality profile, but the diastatic power level was low and the S/T ratio was below

the desired limit. Drummond performed well in this experiment, but protein modification was insufficient, resulting in low soluble protein and S/T values.

In general, most submissions from each of the locations performed pretty well, generating mean quality scores ranging from 43 – 47. Submissions from Aberdeen were plump and had good extract values, but protein modification was deficient in most lines grown there. Barleys from Bottineau were extremely plump, but our standard malting protocol generally generated under modified malts. As a result, F – C differences and β-glucan levels were elevated. The barleys from Crookston had the highest mean quality scores. Most of the malt quality parameters were good, with the exception of slightly elevated β-glucan contents. The barleys from Morris performed similarly to those from Crookston, but were a bit thinner. The barleys from Osnabrock were also a bit thin. These submissions had good carbohydrate modification, but insufficient protein modification. As a result, this location had the lowest mean β-glucan levels and F – C differences, as well as the lowest soluble protein, S/T and diastatic power values.

The best performing lines in the 2003 Mississippi Valley Regional Nursery were M109, M115, Lacey, ND17655, 6B98-9170, ND18579 and BT465. M109, M115, Lacey and ND18579 had very good quality profiles, except for elevated turbidities and β-glucan levels. ND17655 also showed a good malt quality profile although protein modification was probably a bit much. 6B98-9170 was plump, but the turbidity and total protein contents were a bit high. BT465 was plump, but had elevated total protein, soluble protein and β-glucan values.

Table 1. Parentage and origin of entries in the 2003 Mississippi Valley Uniform Regional Nursery

Entry#	CI # or Contributor	Name	Parentage
1.	5105	Barbless	Oderbrucker/Lion
2.	15773	Morex	Cree/Bonanza
3.	476976	Robust	Morex/Manker
4.	Busch Ag. Res.	Legacy(6B93-2978)	Bumper/Karl//Bumper/Manker/3/Bumper/Karl/4/Excel
5.	PI 615584	Drummond (ND15477)	ND9712//Stander/ND12200
6.	PI 613603	Lacey (M98)	M78/M79
7.	North Dakota	Conlon	Bowman*2/Brigitta mutant//ND10232
8.	Busch Ag.	Tradition(6B95-2482)	6B89-2126/ND10981
9.	Minnesota	M109	Lacey/M95
10.	Busch Ag. Res.	6B98-9170	6B92-7098//6B92-7098/M75
11.	Busch Ag. Res.	6B98-9339	B1614//B1614/M75
12.	Minnesota	M112	M93-121/M81
13.	North Dakota	ND17643	ND15245/ND15377
14.	North Dakota	ND17655	ND15245/ND15377
15.	North Dakota	ND17711	ND15246/ND15377
16.	Minnesota	M115	M94-33/M94-111
17.	Minnesota	M116	M104/M81
18.	Minnesota	M117	M94-33/M94-5
19.	North Dakota	ND18578	ND15483/ND15614
20.	North Dakota	ND18579	ND15483/ND15614
21.	North Dakota	ND18650	ND15483/ND15925
22.	North Dakota	2ND19098	ND16680//CMB85-533-H/ND15403-3
23.	North Dakota	2ND19119	ND15403-3/ND15368//ND16453
24.	North Dakota	2ND19929	TR258/ND17437
25.	Busch Ag. Res.	6B99-6339	6B92-8177/6B94-7862
26.	Busch Ag. Res.	6B99-6639	B1614//6B92-7166/B1614
27.	Busch Ag. Res.	6B99-6774	Legacy/6B94-7862
28.	Manitoba	Newdale	CDC Stratus//TR236/WM862-6
29.	Saskatchewan	BT485	M85/SM94021
30.	Saskatchewan	BT490	SM95096/SM94043

*Entries 16-30 are new for 2003.

MISSISSIPPI VALLEY UNIFORM BARLEY NURSERY - 2003 Crop

Table 2 - Station Means* of Barley and Malt Quality Factors for 30 Varieties or Selections**.

LOCATION	Kernel Weight (mg)		on 6/64" (%)		Barley Color (Agtron)		Malt Extract (%)		F - C (%)		Wort Color		Turbidity (HACH)		Barley Protein (%)		Wort Protein (%)		S/T (%)		DP (°ASBC)		Alpha-amylase (20°DU)		Beta-glucan (ppm)		FAN (ppm)		Quality Score
Crookston, MN	36.9	AB	87.7	B	36.6	C	79.4	A	1.0	A	2.09	A	7.3	A	13.2	A	5.51	B	43.1	A	167	A	63.2	A	334	B	233	B	47
Morris, MN	35.3	B	79.9	C	44.4	B	78.6	B	0.9	A	2.15	AB	10.1	AB	13.4	AB	5.44	B	42.1	A	159	AB	64.9	A	241	A	252	C	45
Bottineau, ND	37.4	A	92.5	A	44.1	B	77.0	C	1.8	B	2.29	B	11.9	B	13.7	B	5.46	B	41.6	A	153	B	55.4	B	523	C	256	C	43
Osnabrock, ND	36.1	AB	78.7	C	48.9	A	78.4	B	0.9	A	2.01	A	12.4	B	13.2	A	5.03	A	39.0	B	147	B	58.2	B	181	A	200	A	44

* Within each column, means followed by the same letter are not significantly different (alpha=0.05), according to Duncan's Multiple Range test

** Barbless, Morex, Robust, Legacy, Drummond, Lacey, Conlon, Tradition, M109, 6B98-9170, 6B98-9339, M112, ND17643 ND17655, ND17711, M115, M116, M117, ND18578, ND18579, ND18650, 2ND19098, 2ND19119, 2ND19929, 6B99-6339, 6B99-6639, 6B99-6774, Newdale, BT485, BT490

MISSISSIPPI VALLEY UNIFORM REGIONAL NURSERY - 2003 CROP

Table 3 - Varietal Means* of Barley and Malt Quality Factor for Four Stations**

Variety or Selection	Rowed	Kernel Weight (mg)		on 6/64" (%)		Barley Color (Agtron)		Malt Extract (%)		F-C		Wort Color		Turbidity		Wort Clarity	Barley Protein (%)		Wort Protein (%)		S/T (%)		DP (°ASBC)		Alpha-amylase (20°DU)		Beta-glucan (ppm)		FAN		Quality Score
BARBLESS	6	34.0	HIJK	74.8	EF	42.5	B	74.9	G	1.9	CD	1.95	ABCDE	12.3	AB	1.3	14.5	FG	4.71	DE	33.3	I	139	FGHI	47.1	F	563	C	220	EFGH	22.8
MOREX	6	32.7	K	71.5	F	43.3	B	77.8	EF	1.5	ABCD	1.98	ABCDE	6.9	A	1.0	14.5	G	5.52	ABC	39.6	DEFGH	179	ABC	59.9	CDE	314	ABC	226	ABCDEFG	29.5
ROBUST	6	34.0	HIJK	76.9	DEF	45.0	AB	77.9	DEF	1.9	D	1.75	AB	5.6	A	1.0	14.0	EFG	5.22	BCD	39.1	EFGH	163	BCDEFG	47.3	F	470	BC	201	DEFGH	37.8
LEGACY	6	33.3	JK	80.5	BCDEF	45.0	AB	78.9	BCDEF	0.9	ABCD	2.20	CDEF	6.4	A	1.0	13.4	CDE	5.69	AB	44.5	ABCD	158	BCDEFG	65.7	BC	418	BC	241	ABCDEFG	46.8
DRUMMOND	6	34.5	HIJK	85.2	ABCDE	45.5	AB	78.8	BCDEF	0.8	ABCD	2.13	BCDEF	10.7	AB	1.0	13.5	DEF	5.49	ABC	41.9	BCDEFG	165	BCDEF	59.0	CDE	326	ABC	237	ABCDEFG	49.8
LACEY	6	35.6	FGHIJ	85.2	ABCDE	42.5	B	79.2	BCD	0.9	ABCD	2.23	CDEF	14.7	AB	1.0	13.2	ABCDE	5.36	ABCD	41.3	BCDEFG	167	BCDE	58.4	CDE	224	AB	221	BCDEFG	53.5
CONLON	2	43.4	B	94.4	A	40.8	B	79.8	AB	0.7	ABCD	1.80	ABC	6.5	A	1.0	13.1	ABCD	4.89	CD	37.9	GHI	125	IJ	61.9	CDE	222	AB	192	FGH	46.3
TRADITION	6	35.0	GHIJK	85.0	ABCDE	43.5	B	79.2	BCD	0.8	ABCD	2.05	ABCDEF	13.6	AB	1.3	13.7	CDEF	5.14	BCD	38.8	FGH	185	AB	59.5	CDE	251	AB	230	ABCDEFG	45.0
M109	6	35.5	FGHIJ	81.9	ABCDEF	43.5	B	79.7	AB	0.9	ABCD	2.18	CDEF	13.6	AB	1.3	12.9	ABC	5.24	BCD	42.1	BCDEFG	164	BCDEFG	60.4	CDE	303	ABC	236	ABCDEFG	53.8
6B98-9170	6	34.8	GHIJK	84.0	ABCDEF	46.3	AB	78.8	BCDEF	1.3	ABCD	2.05	ABCDEF	13.6	AB	1.3	13.4	CDE	5.26	BCD	40.6	CDEFG	158	BCDEFG	60.7	CDE	285	ABC	243	ABCDEF	50.5
6B98-9339	6	36.3	EFGH	90.3	ABCD	40.0	B	78.9	BCDEF	0.7	ABC	2.23	CDEF	11.1	AB	1.0	13.6	CDE	5.43	ABC	41.1	BCDEFG	159	BCDEFG	58.9	CDE	261	ABC	257	ABCDE	49.3
M112	6	35.8	FGHIJ	85.8	ABCDE	42.5	B	79.0	BCDE	1.3	ABCD	2.20	CDEF	14.4	AB	1.3	13.0	ABCD	5.24	BCD	41.4	BCDEFG	164	BCDEFG	58.0	CDE	309	ABC	212	CDEFGH	47.5
ND17643	6	36.0	FGHI	88.9	ABCD	44.5	AB	78.8	BCDEF	0.9	ABCD	2.15	BCDEF	8.4	AB	1.0	13.6	CDE	5.76	AB	43.7	ABCDEF	175	ABC	63.8	BCD	285	ABC	263	ABC	48.3
ND17655	6	37.2	DEFG	87.8	ABCDE	43.0	B	79.3	ABC	0.6	AB	2.28	DEF	7.6	A	1.0	13.1	ABCDE	5.81	AB	45.5	ABC	179	ABC	66.1	BC	204	AB	269	ABC	52.0
ND17711	6	33.6	IJK	81.0	ABCDEF	45.5	AB	78.9	BCDEF	0.9	ABCD	2.05	ABCDEF	11.6	AB	1.0	13.0	ABCD	5.60	AB	44.2	ABCDE	162	BCDEFG	62.2	CDE	328	ABC	262	ABC	50.0
M115	6	35.8	FGHIJ	86.4	ABCDE	41.5	B	79.4	ABC	1.2	ABCD	2.23	CDEF	12.1	AB	1.3	13.1	ABCDE	5.46	ABC	43.0	ABCDEFG	154	CDEFGH	61.8	CDE	280	ABC	239	ABCDEFG	53.8
M116	6	34.8	GHIJK	86.2	ABCDE	42.8	B	78.6	BCDEF	1.4	ABCD	2.20	CDEF	9.7	AB	1.0	13.6	CDE	5.42	ABC	41.9	BCDEFG	154	CDEFGH	61.8	CDE	370	ABC	238	ABCDEFG	45.8
M117	6	36.0	FGHI	86.6	ABCDE	42.3	B	78.7	BCDEF	1.4	ABCD	2.20	EF	15.3	AB	1.3	13.6	CDE	5.33	ABCD	40.9	CDEFG	166	BCDEF	57.6	CDE	324	ABC	243	ABCDEF	45.5
ND18578	6	35.2	GHIJK	86.1	ABCDE	42.0	B	78.6	BCDEF	1.8	BCD	2.35	EF	12.3	AB	1.0	13.7	CDE	5.50	ABC	41.6	BCDEFG	172	BCD	58.0	CDE	418	BC	259	ABCD	45.0
ND18579	6	34.2	HIJK	83.8	ABCDEF	42.8	B	78.7	BCDEF	1.0	ABCD	2.35	EF	15.0	AB	1.0	13.3	BCDE	5.44	ABC	42.6	BCDEFG	163	BCDEFG	59.2	CDE	358	ABC	236	ABCDEFG	50.5
ND18650	6	34.0	HIJK	82.8	ABCDEF	45.5	AB	78.1	CDEF	1.2	ABCD	2.28	DEF	15.2	AB	1.0	13.3	BCDE	5.16	BCD	40.8	CDEFG	152	EFGHI	61.2	CDE	401	BC	218	CDEFGH	43.3
2ND19098	2	43.9	B	90.4	ABCD	37.3	B	79.5	ABC	1.2	ABCD	1.65	A	7.0	A	1.0	12.5	AB	4.21	E	35.3	HI	94	K	52.3	EF	430	BC	181	GH	34.0
2ND19119	2	48.0	A	94.0	AB	43.3	B	80.6	A	1.3	ABCD	2.35	EF	8.4	AB	1.0	12.4	A	5.70	AB	47.9	A	108	JK	63.9	BCD	175	AB	286	A	48.0
2ND19929	2	40.7	C	87.2	ABCDE	42.0	B	78.0	DEF	0.4	A	1.88	ABCD	7.9	AB	1.0	12.9	ABC	4.71	DE	38.0	GHI	127	HIJ	53.6	DEF	269	ABC	163	H	34.0
6B99-6339	6	34.7	GHIJK	82.2	ABCDEF	44.0	AB	77.6	F	1.1	ABCD	2.08	BCDEF	6.8	A	1.0	13.9	DEFG	5.39	ABC	39.9	DEFGH	179	ABC	63.7	BCD	338	ABC	238	ABCDEFG	32.5
6B99-6639	6	39.1	CD	91.9	ABC	40.3	B	78.9	BCDEF	1.2	ABCD	2.10	BCDEF	6.4	A	1.0	13.9	DEFG	5.73	AB	42.4	BCDEFG	199	A	57.2	CDE	264	ABC	281	AB	42.8
6B99-6774	6	34.5	HIJK	84.1	ABCDEF	45.5	AB	79.8	AB	1.3	ABCD	2.33	EF	7.0	A	1.0	13.2	ABCDE	5.95	A	46.3	AB	174	ABC	72.9	AB	300	ABC	270	ABC	44.0
NEWDALE	2	37.9	DEF	79.5	CDEF	42.5	B	79.7	AB	0.7	ABCD	1.93	ABCDE	4.6	A	1.0	13.4	BCDE	5.52	ABC	42.2	BCDEFG	135	DEFGHI	80.5	A	76	A	222	BCDEFG	42.5
BT485	6	38.6	CDE	87.8	ABCDE	45.3	AB	79.2	BCD	1.0	ABCD	2.45	F	9.9	AB	1.0	13.4	CDE	5.69	AB	43.8	ABCDEF	141	EFGHI	60.9	CDE	362	ABC	264	ABC	50.5
BT490	6	34.1	HIJK	80.0	CDEF	55.0	A	79.4	ABC	1.6	ABCD	2.45	F	18.5	B	1.3	13.3	BCDE	5.27	BCD	41.4	BCDEFG	136	GHI	60.0	CDE	465	BC	251	ABCDEF	45.3

* Within each column, means followed by the same letter are not significantly different (alpha=0.05), according to Duncan's Multiple Range Test

** Crookston and Morris, MN, Bottineau and Osnabrock, ND

2003 MISSISSIPPI VALLEY SPRING BARLEY NURSERY - CROOKSTON, MN

Table 4

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	F-C	Wort Color	Turbidity	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Quality Score	Overall Rank
5142	BARBLESS	6	34.5	*74.1	38	76.5	1.8	1.9	4.8	1	14.2	5.27	37.5	141	52.8	632	223	31	29
5143	MOREX	6	33.2	*70.8	39	78.9	1.1	2.2	5.7	1	14.3	6.00	44.3	190	64.3	378	239	30	30
5144	ROBUST	6	34.6	83.6	39	79.2	1.6	1.8	4.2	1	13.4	5.48	41.9	158	48.4	598	206	53	9
5145	LEGACY (6B93-2978)	6	34.3	86.3	38	79.7	0.8	2.3	5.7	1	12.7	6.07	49.6	156	69.6	518	235	46	17
5146	DRUMMOND (ND15477)	6	35.3	89.5	41	80.3	0.8	2.1	6.9	1	12.8	5.72	44.6	159	63.6	484	222	54	8
5147	LACEY (M98)	6	36.3	88.8	33	80.8	1.2	2.1	9.1	1	12.8	5.61	44.2	178	61.3	303	243	58	2
5148	CONLON	2	42.3	89.9	36	80.6	1.0	1.8	3.8	1	13.0	5.11	40.6	123	67.1	308	213	48	16
5149	TRADITION (6B95-2482)	6	36.2	85.1	33	80.9	1.4	1.8	6.7	1	13.2	5.51	43.8	196	62.3	294	234	55	5
5150	M109	6	37.0	88.5	35	81.0	1.2	1.9	9.9	1	12.6	5.27	42.1	186	58.2	410	227	55	5
5151	6B98-9170	6	35.3	88.0	37	77.7	1.2	1.8	*27	2	13.1	4.12	*31.6	175	48.7	136	153	46	17
5152	6B98-9339	6	37.3	91.6	33	79.8	1.1	2.2	*13.8	1	13.5	5.61	42.5	177	57.0	183	250	61	1
5153	M112	6	37.4	92.2	34	80.2	0.4	1.7	8.4	1	12.7	5.03	41.7	197	60.9	189	203	49	14
5154	ND17643	6	37.5	93.0	36	79.1	0.7	2.4	6.4	1	13.7	6.18	46.4	221	69.1	231	278	39	23
5155	ND17655	6	38.7	92.2	34	79.3	0.8	2.4	7.1	1	13.9	6.21	46.4	206	71.7	190	277	42	20
5157	ND17711	6	34.6	90.7	37	79.2	1.2	2.3	4.5	1	13.5	5.99	46.4	173	65.7	367	274	49	14
5158	M115	6	38.0	92.4	37	80.3	1.1	2.2	6.9	1	12.7	5.65	44.8	176	66.5	240	247	58	2
5159	M116	6	35.3	91.9	33	79.0	1.8	2.2	6.6	1	13.8	5.55	43.1	151	64.9	491	245	50	13
5160	M117	6	37.3	90.8	33	78.7	1.3	2.1	8.8	1	14.4	5.60	41.6	207	59.1	289	230	33	28
5161	ND18578	6	33.8	80.5	30	78.5	1.4	2.4	6.0	1	14.3	5.88	43.7	180	65.5	513	267	38	24
5162	ND18579	6	34.8	86.7	36	79.5	1.1	2.2	6.4	1	13.7	5.58	42.5	163	62.6	433	246	53	9
5163	ND18650	6	34.6	86.3	38	78.2	0.4	2.0	6.6	1	13.0	5.35	42.6	165	67.8	357	228	52	11
5164	2ND19098	2	41.7	88.2	29	80.3	1.7	1.8	5.8	1	12.6	4.53	38.1	90	53.1	545	170	36	26
5165	2ND19119	2	44.5	90.7	36	80.5	0.5	2.4	7.8	1	12.1	5.68	48.2	105	68.4	191	254	46	17
5166	2ND19929	2	39.1	83.5	38	78.0	0.1	1.6	4.7	1	12.6	4.36	37.3	126	53.4	195	160	35	27
5167	6B99-6339	6	35.2	86.6	38	77.6	0.4	2.1	6.4	1	13.6	5.38	41.2	177	65.9	374	228	38	24
5168	6B99-6639	6	40.9	96.0	32	79.3	0.9	2.0	6.1	1	13.5	5.52	42.4	212	59.1	255	239	51	12
5169	6B99-6774	6	35.5	91.7	35	79.7	0.3	2.3	5.0	1	12.4	6.07	48.9	207	78.9	144	267	42	20
5170	NEWDALE	2	37.5	80.3	32	80.1	1.8	2.3	4.1	1	13.1	5.85	45.4	141	82.0	67	237	40	22
5171	BT485	6	39.3	93.5	36	79.6	0.1	2.3	6.7	1	13.2	5.64	44.8	141	62.6	334	247	58	2
5172	BT490	6	36.2	86.9	*71	80.0	1.0	2.1	7.1	1	12.6	5.52	44.3	139	65.3	369	249	55	5
5156	MOREX MALT CHECK	6	34.5	87.0	76	78.9	1.0	1.9	14.6	2	12.5	4.94	40.4	173	55.1	162	200	48	
Minima			33.2	80.3	29	76.5	0.1	1.6	3.8		12.1	4.12	37.3	90	48.4	67	153	30	
Maxima			44.5	96.0	41	81.0	1.8	2.4	9.9		14.4	6.21	49.6	221	82.0	632	278	61	
Means			36.9	88.8	35	79.4	1.0	2.1	6.4		13.2	5.51	43.5	167	63.2	334	233	47	
Standard Deviations			2.7	3.9	3	1.1	0.5	0.2	1.5		0.6	0.50	3.0	32	7.6	146	31	9	
Coefficients of Variation			7.3	4.4	8	1.3	49.9	10.7	23.9		4.7	9.04	7.0	19	12.1	44	13	19	

Malt Check Data are Excluded from Rank Sorting and Statistics

Table Data Flagged by an Asterisk Exceed the Mean by +/- 3 Standard Deviations and are Excluded from Statistics

For Wort Clarity - 1 = clear, 2 = slightly hazy, 3 = hazy; Wort Colors were not determined (n.d.) on hazy samples

Samples Submitted by K. Smith, University of Minnesota - St. Paul

2003 MISSISSIPPI VALLEY SPRING BARLEY NURSERY - MORRIS, MN

Table 5

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	F-C	Wort Color	Turbidity	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Quality Score	Overall Rank
5173	BARBLESS	6	33.9	70.8	43	*75.2	1.5	1.7	6.0	1	14.9	4.95	35.3	156	50.8	407	215	24	28
5174	MOREX	6	31.9	69.9	44	77.7	1.1	1.9	5.3	1	14.8	5.56	40.1	195	68.4	264	217	24	28
5175	ROBUST	6	33.0	66.6	44	77.8	1.6	1.8	5.0	1	14.1	5.37	40.7	177	52.8	387	194	32	26
5176	LEGACY (6B93-2978)	6	30.8	71.5	35	78.6	0.7	2.1	4.8	1	13.8	5.76	44.6	164	69.4	327	257	40	23
5177	DRUMMOND (ND15477)	6	33.1	78.0	45	78.4	0.5	2.1	9.2	1	13.5	5.51	42.2	176	60.9	132	268	55	2
5178	LACEY (M98)	6	33.5	77.6	46	78.0	0.9	2.1	14.6	1	13.5	5.22	39.0	176	59.2	169	202	48	15
5179	CONLON	2	43.0	95.8	41	79.6	0.8	1.7	7.9	1	13.3	5.05	38.1	123	65.9	229	176	45	17
5180	TRADITION (6B95-2482)	6	33.4	81.0	44	78.6	0.5	1.9	6.1	1	14.0	5.10	38.0	178	63.4	211	251	41	21
5181	M109	6	34.0	77.0	45	78.4	0.1	2.1	10.2	1	12.5	5.06	43.6	156	65.4	160	255	52	9
5182	6B98-9170	6	33.8	78.5	48	78.7	1.3	2.1	15.5	1	13.4	5.75	44.3	152	68.3	367	283	49	14
5183	6B98-9339	6	34.2	84.5	40	78.8	0.4	2.2	5.6	1	13.4	5.52	41.7	158	70.5	186	269	53	4
5184	M112	6	33.9	82.3	43	78.1	1.1	2.1	4.4	1	13.0	5.27	41.2	166	60.1	313	208	47	16
5185	ND17643	6	33.5	79.8	49	79.4	1.3	2.0	11.6	1	12.8	5.60	45.1	154	70.5	169	310	59	1
5186	ND17655	6	35.3	78.9	49	79.2	0.4	2.0	5.3	1	12.8	5.71	45.8	165	67.9	143	274	55	2
5188	ND17711	6	31.9	73.6	50	79.1	0.5	2.1	25.0	1	12.1	5.55	47.3	156	67.9	156	269	53	4
5189	M115	6	36.0	84.6	40	79.3	0.6	2.2	5.4	1	13.9	5.77	43.5	165	64.6	161	262	52	9
5190	M116	6	34.2	81.8	46	78.6	1.4	2.2	7.4	1	13.9	5.56	41.5	157	63.6	315	259	45	17
5191	M117	6	34.4	81.2	45	79.0	1.3	2.4	19.8	1	13.3	5.33	40.1	153	60.8	365	269	53	4
5192	ND18578	6	34.2	80.5	41	78.7	0.8	2.5	9.7	1	13.5	5.78	44.3	175	64.4	249	305	51	11
5193	ND18579	6	33.2	73.1	45	78.5	0.6	2.7	21.0	1	12.8	5.65	46.7	165	63.6	289	262	53	4
5194	ND18650	6	32.9	78.5	47	78.1	0.4	2.5	19.2	1	13.3	5.28	42.5	147	65.9	183	224	53	4
5195	2ND19098	2	44.5	93.6	37	79.7	0.9	1.7	5.6	1	12.8	4.31	34.9	95	52.9	254	182	36	25
5196	2ND19119	2	*47.7	95.0	43	80.1	0.6	2.5	4.5	1	12.7	5.89	47.7	110	68.4	99	331	50	13
5197	2ND19929	2	41.8	89.9	42	78.1	0.8	1.8	5.1	1	12.9	4.47	36.3	127	58.6	163	179	40	23
5198	6B99-6339	6	33.1	73.7	47	77.4	0.9	2.3	7.2	1	14.3	5.79	40.8	192	70.7	237	263	24	28
5199	6B99-6639	6	38.7	91.6	43	78.4	0.6	2.2	6.1	1	14.1	5.82	42.0	222	62.1	128	320	41	21
5200	6B99-6774	6	32.7	78.5	47	80.4	0.6	2.4	5.8	1	13.1	6.06	47.9	174	81.0	142	305	44	19
5201	NEWDALE	2	36.6	77.5	47	79.7	0.8	1.8	3.5	1	13.4	5.52	42.9	142	83.9	104	236	44	19
5202	BT485	6	36.7	84.8	45	78.6	0.9	2.3	5.4	1	13.4	5.70	43.9	155	68.2	257	267	51	11
5203	BT490	6	31.6	68.2	51	78.1	*2.3	*3.1	*40	2	14.0	5.21	40.0	134	56.5	*656	261	32	26
5187	MOREX MALT CHECK	6	34.6	83.6	77	78.9	0.6	2.0	4.9	1	12.5	5.14	42.5	146	53.4	343	214	51	
Minima			30.8	66.6	35	77.4	0.1	1.7	3.5		12.1	4.31	34.9	95	50.8	99	176	24	
Maxima			44.5	95.8	51	80.4	1.6	2.7	25.0		14.9	6.06	47.9	222	83.9	407	331	59	
Means			34.8	79.9	44	78.7	0.8	2.1	9.0		13.4	5.44	42.1	159	64.9	226	252	45	
Standard Deviations			3.3	7.7	4	0.7	0.4	0.3	5.8		0.6	0.40	3.5	25	7.2	89	42	10	
Coefficients of Variation			9.5	9.6	8	0.9	44.4	12.6	64.2		4.8	7.31	8.3	16	11.1	39	17	22	

Malt Check Data are Excluded from Rank Sorting and Statistics

Table Data Flagged by an Asterisk Exceed the Mean by +/- 3 Standard Deviations and are Excluded from Statistics

For Wort Clarity - 1 = clear, 2 = slightly hazy, 3 = hazy; Wort Colors were not determined (n.d.) on hazy samples

Samples Submitted by K. Smith, University of Minnesota - St. Paul

2003 MISSISSIPPI VALLEY SPRING BARLEY NURSERY - BOTTINEAU, ND

Table 6

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	F-C	Wort Color	Turbidity	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN (ppm)	Quality Score	Overall Rank
5204	BARBLESS	6	33.6	86.0	38	*75.8	2.8	2.5	27.0	2	14.8	4.88	33.2	149	42.9	770	209	25	30
5205	MOREX	6	33.2	84.1	45	77.7	2.9	2.0	8.7	1	14.8	5.53	38.5	165	48.9	525	236	33	25
5206	ROBUST	6	34.3	83.9	47	77.1	3.6	1.6	4.5	1	14.9	5.06	35.6	162	41.4	708	196	26	29
5207	LEGACY (6B93-2978)	6	33.9	89.2	49	78.6	1.8	2.2	6.9	1	13.6	5.47	41.4	141	54.1	645	230	45	13
5208	DRUMMOND (ND15477)	6	34.7	91.4	48	78.4	1.4	2.1	7.8	1	14.4	5.69	41.5	154	54.7	591	246	40	22
5209	LACEY (M98)	6	37.7	96.6	46	79.3	1.2	2.8	24.0	2	13.4	5.65	42.6	150	52.7	342	237	57	1
5210	CONLON	2	44.9	97.8	44	79.5	0.7	1.9	8.1	1	13.3	4.92	36.9	122	53.6	279	207	45	13
5211	TRADITION (6B95-2482)	6	36.4	95.7	48	79.2	0.9	2.4	19.6	2	13.8	5.37	38.9	177	54.6	399	250	47	10
5212	M109	6	36.4	89.6	45	80.0	1.4	2.5	18.3	2	13.0	5.45	43.4	152	58.6	538	250	57	1
5213	6B98-9170	6	36.2	93.0	49	79.3	1.5	2.4	4.5	1	13.7	5.78	44.8	143	56.5	526	291	49	8
5214	6B98-9339	6	37.2	96.3	42	79.0	0.9	2.6	6.1	1	14.0	6.03	45.6	150	55.3	404	309	43	18
5215	M112	6	38.0	96.3	42	78.7	2.1	2.5	26.0	2	13.0	5.19	41.4	135	49.1	628	236	42	20
5216	ND17643	6	37.3	95.6	45	78.6	1.4	2.1	6.1	1	14.6	6.00	42.5	163	51.9	611	288	41	21
5217	ND17655	6	38.7	96.4	41	79.4	0.6	2.5	6.3	1	13.5	6.05	46.7	179	59.8	390	293	46	11
5219	ND17711	6	32.0	83.4	47	78.7	1.8	2.0	6.2	1	13.4	5.76	43.7	157	57.2	627	288	51	6
5220	M115	6	35.7	88.8	47	79.2	2.5	2.4	21.0	2	13.2	5.15	41.5	149	52.7	608	234	48	9
5221	M116	6	35.8	94.8	46	78.8	1.9	2.5	13.8	1	13.2	5.48	43.8	153	57.0	469	272	55	4
5222	M117	6	36.6	94.5	44	79.0	2.2	2.5	19.6	2	13.0	5.38	44.7	158	53.7	471	245	57	1
5223	ND18578	6	36.4	95.0	45	78.6	2.4	2.5	17.8	1	13.8	5.41	40.6	169	47.1	698	256	45	13
5224	ND18579	6	34.2	92.3	42	78.9	1.7	2.4	14.8	1	13.7	5.60	42.7	163	56.3	536	270	50	7
5225	ND18650	6	34.1	85.1	49	77.4	2.1	2.6	23.0	1	14.0	5.05	38.8	144	55.8	738	261	29	28
5226	2ND19098	2	46.3	94.9	35	78.4	1.2	1.5	6.9	1	12.7	4.11	35.0	92	53.6	611	214	33	25
5227	2ND19119	2	*50.7	97.2	40	80.3	3.6	2.5	6.5	1	13.0	5.76	47.8	110	60.6	366	338	43	18
5228	2ND19929	2	42.0	96.2	40	78.0	0.6	2.3	5.8	1	13.1	5.90	46.4	133	55.8	514	206	38	23
5229	6B99-6339	6	35.6	90.5	42	77.9	1.5	1.8	4.8	1	14.0	4.78	36.3	186	61.0	415	264	32	27
5230	6B99-6639	6	39.4	97.2	37	79.0	1.8	2.2	4.6	1	14.3	6.22	45.0	207	54.2	426	293	34	24
5231	6B99-6774	6	36.1	92.9	45	79.7	3.0	2.4	5.6	1	13.7	5.96	45.5	182	*72.7	614	286	46	11
5232	NEWDALE	2	38.7	89.2	44	79.5	0.1	1.9	3.4	1	13.5	5.57	42.1	140	*77.0	111	247	52	5
5233	BT485	6	40.5	96.1	47	79.3	1.5	2.7	14.0	1	14.3	5.82	42.3	151	56.1	587	278	44	16
5234	BT490	6	36.2	94.4	45	80.2	1.7	2.3	16.3	1	13.8	4.91	38.3	144	57.4	536	305	44	16
5218	MOREX MALT CHECK	6	35.0	88.1	79	78.2	2.4	3.2	38.0	3	12.9	4.94	39.6	130	52.5	564	193	38	
Minima			32.0	83.4	35	77.1	0.1	1.5	3.4		12.7	4.11	33.2	92	41.4	111	196	25	
Maxima			46.3	97.8	49	80.3	3.6	2.8	27.0		14.9	6.22	47.8	207	61.0	770	338	57	
Means			37.0	92.5	44	78.9	1.8	2.3	11.9		13.7	5.46	41.6	153	54.0	523	258	43	
Standard Deviations			3.3	4.5	4	0.8	0.9	0.3	7.5		0.6	0.46	3.7	22	4.7	145	35	9	
Coefficients of Variation			8.8	4.8	8	1.0	48.9	14.0	62.7		4.3	8.50	9.0	15	8.7	28	13	21	

Malt Check Data are Excluded from Rank Sorting and Statistics

Table Data Flagged by an Asterisk Exceed the Mean by +/- 3 Standard Deviations and are Excluded from Statistics

For Wort Clarity - 1 = clear, 2 = slightly hazy, 3 = hazy; Wort Colors were not determined (n.d.) on hazy samples

Samples Submitted by B. Cooper and S. Askelson, BARI - Ft. Collins

2003 MISSISSIPPI VALLEY REGIONAL NURSERY - OSNABROCK, ND

Table 7

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	F-C	Wort Color	Turbidity	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN	Quality Score	Overall Rank
5095	BARBLESS	6	33.8	68.4	51	*72.2	1.5	1.7	11.5	1	14.1	3.75	27.2	108	41.7	442	145	11	30
5096	MOREX	6	32.5	61.1	45	77.0	0.7	1.8	7.9	1	14.2	4.99	35.4	166	57.9	88	211	31	27
5097	ROBUST	6	34.0	73.4	50	77.5	0.9	1.8	8.7	1	13.4	4.95	38.0	153	46.6	187	207	40	19
5098	LEGACY (6B93-2978)	6	34.0	75.1	58	78.5	0.4	2.2	8.1	1	13.4	5.47	42.3	172	69.5	181	243	56	4
5099	DRUMMOND (ND15477)	6	34.8	82.0	48	78.1	0.6	2.2	18.7	1	13.3	5.03	39.4	172	56.9	96	213	50	10
5100	LACEY (M98)	6	35.0	77.6	45	78.5	0.4	1.9	11.0	1	13.0	4.96	39.2	165	60.4	82	202	51	8
5101	CONLON	2	43.4	94.0	42	79.3	0.4	1.8	6.3	1	12.6	4.46	36.0	130	61.1	70	172	47	13
5102	TRADITION (6B95-2482)	6	33.8	78.2	49	78.0	0.5	2.1	22.0	1	13.9	4.59	34.3	190	57.6	99	183	37	23
5103	M109	6	34.4	72.4	49	79.2	1.0	2.2	16.0	1	13.4	5.18	39.1	160	59.4	102	210	51	8
5104	6B98-9170	6	34.0	76.4	51	79.3	1.2	1.9	7.3	1	13.4	5.39	41.7	161	69.1	109	247	58	2
5105	6B98-9339	6	36.4	88.8	45	77.9	0.3	1.9	19.0	1	13.4	4.56	34.4	150	52.6	269	200	40	19
5106	M112	6	33.9	72.3	51	78.8	1.7	2.5	18.8	1	13.4	5.48	41.3	156	62.0	104	202	52	7
5107	ND17643	6	35.7	87.2	48	78.2	0.1	2.1	9.5	1	13.3	5.26	40.6	160	63.6	127	175	54	5
5108	ND17655	6	36.1	83.8	48	79.4	0.6	2.2	11.6	1	12.3	5.26	43.2	166	64.9	91	230	65	1
5109	ND17711	6	35.9	76.1	48	78.5	0.1	1.8	10.5	1	13.1	5.08	39.4	161	57.9	163	218	47	13
5110	M115	6	33.5	79.9	42	78.8	0.4	2.1	15.2	1	12.6	5.27	42.3	126	63.5	110	212	57	3
5111	M116	6	33.9	72.4	46	78.0	0.6	1.9	11.1	1	13.5	5.07	39.0	154	61.5	203	174	33	26
5112	M117	6	35.5	79.7	47	77.9	0.7	1.8	12.9	1	13.7	5.01	37.2	145	56.9	172	230	39	21
5113	ND18578	6	36.5	88.5	52	78.4	2.5	2.0	15.7	1	13.2	4.93	37.9	163	54.9	213	209	46	15
5114	ND18579	6	34.6	82.9	48	77.9	0.4	2.1	17.7	1	12.9	4.93	38.6	162	54.1	174	167	46	15
5115	ND18650	6	34.4	81.3	48	78.8	1.7	2.0	11.8	1	12.9	4.96	39.4	117	55.2	326	158	39	21
5116	2ND19098	2	43.1	84.7	48	79.4	0.9	1.6	9.6	1	12.0	3.89	33.1	99	49.5	311	159	31	27
5117	2ND19119	2	*49.1	93.2	54	81.3	0.6	2.0	14.9	1	11.6	5.45	48.0	105	58.0	42	221	53	6
5118	2ND19929	2	39.7	79.3	48	77.8	0.1	1.8	16.0	1	13.1	4.09	31.8	123	46.4	204	108	23	29
5119	6B99-6339	6	34.8	77.9	49	77.5	1.5	2.1	8.6	1	13.6	5.61	41.4	162	57.0	327	197	36	24
5120	6B99-6639	6	37.5	82.7	49	78.7	1.4	2.0	8.9	1	13.6	5.34	40.1	155	53.3	245	271	45	17
5121	6B99-6774	6	33.7	73.2	55	79.3	1.1	2.2	11.5	1	13.5	5.72	42.9	131	58.9	299	221	44	18
5122	NEWDALE	2	38.6	71.0	47	79.3	0.2	1.7	7.4	1	13.4	5.15	38.5	152	79.1	23	168	34	25
5123	BT485	6	37.7	76.7	53	79.1	1.5	2.5	13.4	1	12.7	5.58	44.1	116	56.5	270	264	49	12
5124	BT490	6	32.5	70.4	53	79.4	1.5	2.3	10.7	1	12.7	5.42	42.9	127	60.7	298	190	50	10
5094	MOREX MALT CHECK	6	35.4	87.0	76	79.1	0.7	2.1	19.6	1	13.0	5.00	41.3	157	55.8	81	215	56	
Minima			32.5	61.1	42	77.0	0.1	1.6	6.3		11.6	3.75	27.2	99	41.7	23	108	11	
Maxima			43.4	94.0	58	81.3	2.5	2.5	22.0		14.2	5.72	48.0	190	79.1	442	271	65	
Means			35.6	78.7	49	78.6	0.8	2.0	12.4		13.2	5.03	39.0	147	58.2	181	200	43.8	
Standard Deviations			2.7	7.4	4	0.8	0.6	0.2	4.1		0.6	0.49	4.1	23	7.3	102	35	11	
Coefficients of Variation			7.6	9.4	7	1.1	70.0	10.8	33.2		4.4	9.69	10.6	16	12.6	56	18	26	

Malt Check Data are Excluded from Rank Sorting and Statistics

Table Data Flagged by an Asterisk Exceed the Mean by +/- 3 Standard Deviations and are Excluded from Statistics

For Wort Clarity - 1 = clear, 2 = slightly hazy, 3 = hazy; Wort Colors were not determined (n.d.) on hazy samples

Samples Submitted by R. Horsley, NDSU - Fargo

2003 MISSISSIPPI VALLEY REGIONAL NURSERY - ABERDEEN, ID
Table 8

Lab No.	Variety or Selection	Rowed	Kernel Weight (mg)	on 6/64" (%)	Barley Color (Agtron)	Malt Extract (%)	F-C	Wort Color	Turbidity	Wort Clarity	Barley Protein (%)	Wort Protein (%)	S/T (%)	DP (°ASBC)	Alpha-amylase (20°DU)	Beta-glucan (ppm)	FAN	Quality Score	Overall Rank
5000	BARBLESS	6	32.8	*56.5	73	*74.0	2.2	1.6	18.3	1	12.3	3.73	32.3	102	39.4	435	153	21	30
5001	MOREX	6	35.8	84.5	69	78.4	1.3	1.7	14.8	1	13.2	4.46	35.6	144	59.4	152	201	46	8
5002	ROBUST	6	36.7	87.2	70	78.0	1.1	1.4	6.6	1	13.4	4.42	33.5	134	54.0	279	201	37	26
5003	LEGACY (6B93-2978)	6	37.5	89.3	75	78.7	0.7	1.4	6.8	1	12.8	4.72	37.6	142	73.1	227	229	43	14
5004	DRUMMOND (ND15477)	6	36.8	93.9	71	78.2	0.8	1.5	12.6	1	13.0	4.50	36.7	146	63.4	109	180	50	5
5005	LACEY (M98)	6	39.3	91.6	69	78.4	0.9	1.6	13.2	1	13.6	4.58	35.0	128	58.6	171	195	38	24
5006	CONLON	2	47.4	97.8	65	79.4	1.3	2.2	15.0	2	13.0	4.77	38.0	126	62.5	268	208	40	21
5007	TRADITION (6B95-2482)	6	37.3	93.3	71	78.9	0.8	n.d.	47.0	3	11.4	4.16	37.7	131	56.7	192	178	36	28
5008	M109	6	40.1	94.9	69	80.5	0.7	1.6	13.4	1	11.0	4.26	40.9	118	63.2	88	182	41	20
5009	6B98-9170	6	40.1	92.9	77	79.2	0.5	1.8	6.3	1	12.4	5.04	41.3	112	80.1	117	257	46	8
5010	6B98-9339	6	36.7	90.1	75	79.3	0.9	2.7	17.3	1	11.8	5.28	44.8	77	70.5	134	318	58	1
5011	M112	6	39.2	90.0	71	79.4	1.1	2.4	31.0	2	12.0	4.74	40.2	97	53.4	409	189	38	24
5012	ND17643	6	37.8	96.6	75	79.3	0.9	1.6	10.4	1	11.8	4.70	41.9	115	68.5	101	222	46	8
5013	ND17655	6	38.2	87.4	76	78.9	0.8	1.9	9.5	1	12.4	4.87	39.8	122	72.3	89	244	50	5
5014	ND17711	6	35.2	92.4	76	78.8	0.7	1.6	10.3	1	11.6	4.71	41.7	112	65.4	87	225	43	14
5015	M115	6	39.3	94.1	67	79.0	0.8	1.5	8.1	1	12.5	4.69	39.1	108	61.5	106	188	43	14
5016	M116	6	37.2	91.3	68	78.5	0.9	1.6	10.2	1	11.3	4.68	43.3	87	64.1	140	231	39	22
5017	M117	6	38.8	95.4	67	79.1	0.9	1.7	14.9	1	12.1	4.64	41.4	95	59.9	136	212	46	8
5018	ND18578	6	38.1	94.9	72	79.0	2.4	2.0	15.1	1	12.2	4.68	40.8	91	64.1	170	215	42	18
5019	ND18579	6	37.0	93.1	72	79.3	3.0	2.2	28.0	1	12.3	4.55	38.6	102	64.4	210	204	39	22
5020	ND18650	6	37.3	95.2	77	78.7	2.0	1.9	22.0	1	11.8	4.32	38.5	104	63.1	88	174	43	14
5021	2ND19098	2	48.3	95.6	76	79.4	3.0	1.5	11.1	1	12.3	3.89	32.3	91	47.8	302	133	33	29
5022	2ND19119	2	49.3	96.6	73	79.8	0.5	2.9	16.6	1	12.3	5.49	46.1	107	65.4	147	289	55	2
5023	2ND19929	2	45.0	94.3	62	78.1	1.9	1.9	14.2	1	11.5	4.11	36.2	103	54.3	231	159	37	26
5024	6B99-6339	6	37.7	90.9	70	78.1	0.8	2.3	16.9	1	12.5	5.06	43.3	105	67.4	148	243	44	13
5025	6B99-6639	6	39.8	89.3	69	78.5	0.8	2.2	11.2	1	12.7	5.32	43.0	96	70.2	104	275	55	2
5026	6B99-6774	6	36.7	90.8	79	79.4	0.5	2.0	10.1	1	12.6	5.25	42.8	128	69.0	227	253	55	2
5027	NEWDALE	2	41.4	95.9	73	80.0	0.8	1.4	7.1	1	12.2	4.63	39.1	118	71.4	45	187	45	12
5028	BT485	6	41.0	94.2	70	79.6	1.0	1.6	10.6	1	11.2	4.84	45.6	110	66.6	114	221	49	7
5029	BT490	6	35.2	87.5	81	79.8	1.3	1.7	23.0	1	11.9	4.43	38.5	106	64.8	186	199	42	18
5031	MOREX MALT CHECK	6	33.9	86.5	76	79.4	0.7	1.7	8.6	1	13.0	5.22	42.4	157	56.8	65	248	61	
Minima			32.8	84.5	62	78.0	0.5	1.4	6.3		11.0	3.73	32.3	77	39.4	45	133	21	
Maxima			49.3	97.8	81	80.5	3.0	2.9	47.0		13.6	5.49	46.1	146	80.1	435	318	58	
Means			39.1	92.4	72	79.0	1.2	1.8	15.1		12.2	4.65	39.5	112	63.2	174	212	43	
Standard Deviations			3.8	3.3	4	0.6	0.7	0.4	8.5		0.6	0.40	3.7	17	8.1	93	40	7	
Coefficients of Variation			9.8	3.6	6	0.8	59.1	21.0	56.4		5.3	8.70	9.2	16	12.8	53	19	17	

Malt Check Data are Excluded from Rank Sorting and Statistics
Table Data Flagged by an Asterisk Exceed the Mean by +/- 3 Standard Deviations and are Excluded from Statistics
For Wort Clarity - 1 = clear, 2 = slightly hazy, 3 = hazy; Wort Colors were not determined (n.d.) on hazy samples

Samples Submitted by D. Obert, USDA/ARS - Aberdeen, ID

MISSISSIPPI VALLEY UNIFORM BARLEY NURSERY - 2003 Crop

Table 9 - Station Means* of Barley and Malt Quality Factors for 30 Varieties or Selections**.

LOCATION	Kernel Weight (mg)		on 6/64" (%)		Barley Color (Agtron)		Malt Extract (%)		F - C (%)		Wort Color		Turbidity (HACH)		Barley Protein (%)		Wort Protein (%)		S/T (%)		DP (°ASBC)		Alpha-amylase (20°DU)		Beta-glucan (ppm)		FAN (ppm)		Quality Score	
Aberdeen, ID	39.1	A	91.3	A	71.9	A	78.9	AB	1.2	A	1.90	A	15.1	C	12.2	A	4.65	C	39.5	B	112	C	63.2	A	174	A	212	A	43	
Crookston, MN	36.9	BC	87.7	B	36.6	D	79.4	A	1.0	A	2.09	B	7.3	A	13.2	B	5.51	A	43.1	A	167	A	63.2	A	334	C	233	B	47	
Morris, MN	35.3	C	79.9	C	44.4	C	78.6	B	0.9	A	2.15	BC	10	AB	13.4	BC	5.44	A	42.1	A	159	AB	64.9	A	241	B	252	C	45	
Bottineau, ND	37.4	AB	92.5	A	44.1	C	78.8	B	1.8	B	2.29	C	12	BC	13.7	C	5.46	A	41.6	A	153	B	55.4	B	523	D	256	C	43	
Osnabrock, ND	36.1	BC	78.7	C	48.9	B	78.4	B	0.9	A	2.01	AB	12	BC	13.2	B	5.03	B	39.0	B	147	B	58.2	B	181	AB	200	A	44	

* Within each column, means followed by the same letter are not significantly different (alpha=0.05), according to Duncan's Multiple Range test

** Barbless, Morex, Robust, Legacy, Drummond, Lacey, Conlon, Tradition, M109, 6B98-9170, 6B98-9339, M112, ND17643 ND17655, ND17711, M115, M116, M117, ND18578, ND18579, ND18650, 2ND19098, 2ND19119, 2ND19929, 6B99-6339, 6B99-6639, 6B99-6774, Newdale, BT485, BT490

MISSISSIPPI VALLEY UNIFORM REGIONAL NURSERY - 2003 CROP

Table 10 - Varietal Means of Barley and Malt Quality Factor for all Stations** including Aberdeen, ID

Variety or Selection	Rowed	Kernel Weight (mg)		on 6/64" (%)		Barley Color (Agtron)	Malt Extract (%)		F-C		Wort Color		Turbidity		Wort Clarity		Barley Protein (%)		Wort Protein (%)		S/T (%)		DP (°ASBC)		Alpha-amylase (20°DU)		Beta-glucan (ppm)		FAN		Quality Score
BARBLESS	6	33.7	HI	71.2	F	48.6	74.4	J	2.0	D	1.9	ABCD	13.5	ABCDEF	1.2	AB	14.1	DE	4.52	EF	33.1	I	131	CDEF	45.5	H	537	C	189	HIJ	22.4
MOREX	6	33.3	I	74.1	EF	48.4	77.9	GHI	1.4	ABCD	1.9	ABCD	8.5	ABCD	1.0	A	14.3	E	5.31	ABCD	38.8	DEFGH	172	ABC	59.8	CDEF	281	ABC	221	CDEFGHI	32.8
ROBUST	6	34.5	GHI	78.9	DEF	50.0	77.9	HI	1.8	BCD	1.7	AB	5.8	A	1.0	A	13.8	CDE	5.06	BCDE	37.9	FGH	157	ABCD	48.6	GH	432	BC	201	FGHIJ	37.6
LEGACY	6	34.1	HI	82.3	BCDE	51.0	78.8	BCDEFGI	0.9	ABCD	2.0	ABCDE	6.5	AB	1.0	A	13.2	ABCDE	5.50	ABC	43.1	BCDE	155	ABCD	67.1	BC	380	AB	239	ABCDEFGH	46.0
DRUMMOND	6	35.0	GHI	87.0	ABCD	50.6	78.7	CDEFGHI	0.8	ABC	2.0	ABCDE	11.0	ABCDEF	1.0	A	13.4	ABCDE	5.29	ABCD	40.9	CDEFG	162	ABCD	59.9	CDEF	282	ABC	226	CDEFGH	49.8
LACEY	6	36.3	EFGH	86.4	ABCD	47.8	79.0	BCDEFG	0.9	ABCD	2.1	BCDE	14.4	ABCDEF	1.2	AB	13.3	ABCDE	5.21	ABCDE	40.0	CDEFG	159	ABCD	58.4	CDEF	213	AB	216	CDEFGHI	50.4
CONLON	2	44.2	B	95.1	A	45.6	79.7	ABC	0.8	ABC	1.9	ABCD	8.2	ABCD	1.2	AB	13.0	ABCD	4.86	CDE	37.9	FGH	125	DEF	62.0	CDE	231	AB	195	GHIJ	45.0
TRADITION	6	35.4	GHI	86.7	ABCD	49.0	79.1	BCDE	0.8	ABC	2.1	BCDE	20.3	F	1.6	B	13.3	ABCDE	4.94	BCDE	38.5	EFGH	174	AB	58.9	CDEF	239	AB	219	CDEFGHI	43.2
M109	6	36.4	EFGH	84.5	ABCDE	48.6	79.8	AB	0.9	ABCD	2.0	ABCDE	13.6	ABCDEF	1.2	AB	12.5	AB	5.04	BCDE	41.8	BCDEFG	154	ABCD	61.0	CDE	260	AB	225	CDEFGH	51.2
6B98-9170	6	35.9	FGHI	85.8	ABCDE	52.4	78.8	BCDEFGI	1.1	ABCD	2.0	ABCDE	12.1	ABCDEF	1.2	AB	13.2	ABCDE	5.22	ABCDE	40.7	CDEFG	149	ABCD	64.5	BCD	251	AB	246	ABCDEFG	49.6
6B98-9339	6	36.4	EFGH	90.3	ABCD	47.0	79.0	BCDEFGI	0.7	AB	2.3	DE	12.4	ABCDEF	1.0	A	13.2	ABCDE	5.40	ABC	41.8	BCDEFG	142	ABCDE	61.2	CDE	235	AB	269	ABC	51.0
M112	6	36.5	EFGH	86.6	ABCD	48.2	79.4	BCDEF	1.2	ABCD	2.2	CDE	17.7	DEF	1.4	AB	12.8	ABC	5.14	ABCDE	41.2	BCDEFG	150	ABCD	57.1	DEF	329	ABC	208	EFGHIJ	45.6
ND17643	6	36.4	EFGH	90.4	ABCD	50.6	78.9	BCDEFGI	0.9	ABCD	2.0	ABCDE	8.8	ABCD	1.0	A	13.2	ABCDE	5.55	ABC	43.3	ABCD	163	ABCD	64.7	BCD	248	AB	255	ABCDE	47.8
ND17655	6	37.4	DEFG	87.7	ABCD	49.6	79.2	BCDE	0.6	A	2.2	CDE	8.0	ABCD	1.0	A	13.0	ABCD	5.62	AB	44.4	ABC	168	ABC	67.3	BC	181	AB	264	ABCD	51.6
ND17711	6	33.9	HI	83.2	ABCDE	51.6	78.9	BCDEFGI	0.9	ABC	2.0	ABCD	11.3	ABCDEF	1.0	A	12.7	ABC	5.42	ABC	43.7	ABC	152	ABCD	62.8	CDE	280	ABC	255	ABCDE	48.6
M115	6	36.5	EFGH	88.0	ABCD	46.6	79.3	BCD	1.1	ABCD	2.1	ABCDE	11.3	ABCDEF	1.2	AB	13.0	ABCD	5.31	ABCD	42.2	BCDEFG	145	ABCDE	61.8	CDE	245	AB	229	BCDEFGH	51.6
M116	6	35.3	GHI	86.4	ABCD	47.8	78.6	DEFGHI	1.3	ABCD	2.1	ABCDE	9.8	ABCDE	1.0	A	13.2	ABCDE	5.27	ABCD	42.1	BCDEFG	140	ABCDE	62.2	CDE	324	ABC	236	ABCDEFGH	44.4
M117	6	36.5	EFGH	88.3	ABCD	47.2	78.7	CDEFGH	1.3	ABCD	2.1	BCDE	15.2	ABCDEF	1.2	AB	13.3	ABCDE	5.19	ABCDE	41.0	BCDEFG	151	ABCD	58.1	CDEF	286	ABC	237	ABCDEFGH	45.6
ND18578	6	35.8	FGHI	87.9	ABCD	48.0	78.6	CDEFGHI	1.9	CD	2.3	CDE	12.9	ABCDEF	1.0	A	13.4	ABCDE	5.34	ABC	41.5	BCDEFG	155	ABCD	59.2	CDEF	369	AB	250	ABCDEF	44.4
ND18579	6	34.8	GHI	85.6	ABCDE	48.6	78.8	BCDEFGI	1.3	ABCD	2.3	DE	17.6	CDEF	1.0	A	13.1	ABCD	5.26	ABCD	41.8	BCDEFG	151	ABCD	60.2	CDEF	328	ABC	230	BCDEFGH	48.2
ND18650	6	34.7	GHI	85.3	ABCDE	51.8	78.2	EFGHI	1.3	ABCD	2.2	CDE	16.5	BCDEF	1.0	A	13.0	ABCD	4.99	BCDE	40.4	CDEFG	135	BCDE	61.6	CDE	338	ABC	211	EFGHIJ	43.2
2ND19098	2	44.8	B	91.4	ABC	45.0	79.4	ABCD	1.5	ABCD	1.6	A	7.8	ABCD	1.0	A	12.5	AB	4.15	F	34.7	HI	93	F	51.4	FGH	405	AB	172	IJ	33.8
2ND19119	2	48.3	A	94.5	AB	49.2	80.4	A	1.1	ABCD	2.5	E	10.1	ABCDE	1.0	A	12.3	A	5.65	AB	47.6	A	107	EF	64.2	BCD	169	AB	287	A	49.4
2ND19929	2	41.5	C	88.6	ABCD	46.0	78.0	FGHI	0.7	AB	1.9	ABCD	9.2	ABCD	1.0	A	12.6	AB	4.59	DEF	37.6	GH	122	DEF	53.7	EFG	261	AB	163	J	34.6
6B99-6339	6	35.3	GHI	83.9	ABCDE	49.2	77.7	I	1.0	ABCD	2.1	BCDE	8.8	ABCD	1.0	A	13.6	BCDE	5.32	ABCD	40.6	CDEFG	164	ABCD	64.4	BCD	300	ABC	239	ABCDEFGH	34.8
6B99-6639	6	39.3	CD	91.4	ABC	46.0	78.8	BCDEFGI	1.1	ABCD	2.1	BCDE	7.4	ABC	1.0	A	13.6	BCDE	5.64	AB	42.5	BCDEF	178	A	59.8	CDEF	231	AB	280	AB	45.2
6B99-6774	6	34.9	GHI	85.4	ABCDE	52.2	79.7	ABC	1.1	ABCD	2.2	CDE	7.6	ABCD	1.0	A	13.1	ABCD	5.81	A	45.6	AB	164	ABCD	72.1	AB	285	ABC	266	ABCD	46.2
NEWDALE	2	38.6	DEF	84.8	ABCDE	48.6	79.7	ABC	0.7	AB	1.8	ABC	5.1	A	1.0	A	13.1	ABCD	5.34	ABC	41.6	BCDEFG	139	ABCDE	78.7	A	70	A	213	DEFGHI	43.0
BT485	6	39.0	CDE	89.1	ABCD	50.2	79.2	BCDE	1.0	ABCD	2.3	CDE	10.0	ABCDE	1.0	A	12.9	ABCD	5.52	ABC	44.1	ABC	135	BCDE	62.0	CDE	312	ABC	255	ABCDE	50.2
BT490	6	34.3	HI	81.5	CDEF	60.2	79.5	ABCD	1.6	ABCD	2.3	DE	19.4	EF	1.2	AB	13.0	ABCD	5.10	ABCDE	40.8	CDEFG	130	CDEF	60.9	CDE	409	BC	241	ABCDEFGH	44.6

* Within each column, means followed by the same letter are not significantly different (alpha=0.05), according to Duncan's Multiple Range Test

** Aberdeen, ID, Crookston and Morris, MN, Bottineau and Osnabrock, ND

Appendix A: METHODS

Cleaning All samples were cleaned on a Carter Dockage Tester and any material not retained on a 5/64" screen was discarded.

Barley Mill Ground barley was prepared with a Labconco Burr mill that was adjusted so that only 35% of the grist remained on a 525 µm sieve after 3 min of shaking and tapping.

Kernel Weight The number of kernels in a 20 g aliquot of each sample was counted electronically and the '1000 kernel weight' was calculated.

Plumpness Samples were sized on a Eureka-Niagra Barley Grader and the percentage of the seeds retained on a 6/64" screen was determined.

Barley Color The brightness of the grains was measured using an Agtron M45-D analyzer.

Barley Moisture Content Five g of ground sample was dried for 3 h at 106°C. The percentage of weight loss that occurred during this drying was calculated.

Barley Protein Content Total nitrogen values were obtained using an automated Dumas combustion procedure with a LECO FP-528 analyzer. Nitrogen values were converted to protein percentages by multiplication by 6.25.

Malting Conditions 170 g (db) barley samples were steeped at 16° C for 32-48 h, to 45% moisture, by alternating 4 h of wet steep with 4 h of air rest. The steeped samples were placed in a chamber for 5 d at 17° C and near 100% R.H., in cans that were rotated for 3.0 min every 30 min. The germinated grain (green malt) was kilned for 24 h as follows: 0.5 h from 25° C to 49° C, 9.5 h at 49° C, 0.5 h from 49° C to 54° C, 4.0 h at 54° C, 0.5 h from 54° C to 60° C, 3.0 h at 60° C, 0.5 h from 60° C to 68° C, 2.0 h at 68° C, 0.5h from 68° C to 85° C, and 3.0 h at 85° C.

Malt Mill Fine-grind malts were prepared with a Miag laboratory cone mill that was adjusted so that 10% of the grist remained on a 525 µm sieve after 3 min of shaking, with tapping. Coarse-grind malts were prepared with a corrugated roll mill that was adjusted so that 75% of the grist remained on a 525 µm sieve. Ground malts for moisture, protein and amylolytic activity analyses were ground in a Labconco Burr mill (see Barley Mill).

Malt Moisture Content See Barley Moisture Content.

Malt Protein Content See Barley Protein Content.

Malt Extract Samples were extracted using the Malt-4 procedure (Methods of Analysis of the ASBC, 8th ed, 1992), except that all weights and volumes specified for the method were halved. The specific gravity of the filtrate was measured with an Anton/Parr DMA5000 density meter. The density data were used to calculate the amount of soluble material present in the filtrate, and thus the percentage that was extracted from the malt. **F-C** represents the difference in extract % between the finely ground malts and the coarsely ground malts.

Wort Color was determined on a Skalar SAN plus analyzer by subtracting the absorbance at 700 nm from that at 430nm and dividing by a factor that was determined by comparison with values obtained in a collaborative test.

Wort Clarity was assessed by visual inspection.

β-Glucan Levels were determined on a Skalar SAN plus analyzer by using the Wort-18 fluorescence flow injection analysis method with calcofluor as the fluorescent agent (Methods of Analysis of the ASBC, 8th ed, 1992).

Free Amino Nitrogen Levels were determined on a Skalar SAN plus analyzer using an automated version of the Wort-12 protocol (Methods of Analysis of the ASBC, 8th ed, 1992).

Soluble (Wort) Protein Levels were determined on a Skalar SAN plus analyzer using the Wort-17 UV-spectrophotometric method (Methods of Analysis of the ASBC, 8th ed, 1992).

S/T Ratio was calculated as Soluble Protein / Total Malt Protein

Diastatic Power Values were determined on a Skalar SAN plus analyzer by the automated ferricyanide procedure Malt-6A (Methods of Analysis of the ASBC, 8th ed, 1992).

α-Amylase activities were measured on a Skalar SAN plus analyzer by heating the extract to 73°C to inactivate any β-amylase present. The remaining (α-amylase) activity was measured as described for Diastatic Power Values.

Turbidities were determined in Nephelometric Turbidity Units (NTU) on a Hach Model 18900 Ratio Turbidimeter.

Quality Scores were calculated by using a modification of the method of Clancy and Ullrich (Cereal Chem. 65:428-430, 1988). The criteria used to quantify individual quality factors are listed in Table A1.

Overall Rank Values were ordered from low to high based on their Quality Scores. A rank of '1' was assigned to the sample with the best quality score.

Appendix B **Quality Score Parameters**

	2-rowed		6-rowed	
Quality parameter	condition	score	condition	score
Kernel Weight	> 42.0	5	> 32.0	5
(mg)	40.1–42.0	4	30.1–32.0	4
	38.1–40.0	2	28.1–30.0	2
	≤ 38.0	0	≤ 28.0	0
on 6/64 "	≥ 90.0	5	≥ 80.0	5
(%)	85.0–89.9	3	73.0–79.9	3
	< 85.0	0	< 73.0	0
Malt Extract	≥ 81.0	10	≥ 79.0	10
(% db)	79.4–81.0	7	78.2–78.9	7
	78.0–79.4	4	77.7–78.2	4
	<78.0	0	< 77.7	0
Wort Clarity	= 3	0	= 3	0
3=hazy	= 2	1	= 2	1
2=slightly hazy	= 1	2	= 1	2
1=clear				
Barley Protein	≥ 13.5	0	≥ 14.0	0
(% db)	13.0–13.5	5	13.5–13.9	5
	11.5–13.0	10	11.5–13.5	10
	≤ 11.5	5	≤ 11.5	5
Wort Protein	> 6.0	0	> 6.0	0
(% db)	5.6–6.0	3	5.7–6.0	3
	4.9–5.6	7	5.2–5.7	7
	4.5–4.9	3	4.8–5.2	3
	< 4.5	0	< 4.8	0
S/T (Soluble/Total	>47	0	>47	0
Protein, % db)	42–47	5	42–47	5
	< 42	0	< 42	0
DP (Diastatic	> 180	0	> 200	0
Power, ° ASBC)	160–180	4	180–200	4
	120–160	7	140–180	7
	100–120	4	120–140	4
	< 100	0	< 120	0
Alpha-amylase	> 90	0	> 90	0
(20° DU)	80–90	4	80–90	4
	45–80	7	45–80	7
	35–45	4	35–40	4
	< 35	0	< 35	0
Beta-glucan	< 40	0	< 40	0
(ppm)	40 –60	3	40 –80	3
	60 – 115	7	80 – 140	7
	115–200	3	140 – 200	3
	> 200	0	> 200	0